Contest Corner: Are Common Core Standards Addressed by Statewide Mathematics Contest Questions?

Debbie Kuchey and Michael Flick *Xavier University*

1 Introduction

Most of the annual State Tournament of Mathematics questions consist of routine problems found in standard high school mathematics textbooks. All of the problems can be solved using algebra, geometry, and arithmetic. Calculators are allowed. Preparation for this annual contest can be accomplished in a variety of ways. However, many successful schools have mathematics clubs that regularly take short contests for preparation. In Figure 1, we provide an example of a 20 minute mathematics contest that can be used in the classroom or with a mathematics club. It is setup in the format of the *OHIO MATHEMATICS LEAGUE* (`http://www.themathleague.com/`) or the *Atlantic Pacific Math League* (`http://www.atpacmath.com/`) (Flick and Kuchey, 2010).

2 The Project

Is requiring an answer enough? Are the Common Core State Standards for Mathematical Practice being incorporated into the Statewide Mathematics Contest? Let us consider the practice standards, as given in the Common Core State Standards for Mathematics (CCSSM).

1. **Make sense of problems and persevere in solving them.** *Mathematically proficient students start by explaining the meaning of a problem and looking for entry points to in its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt.*

PRACTICE MATHEMATICS CONTEST TIME LIMIT: 20 minutes	ANSWERS
1. In a group of hunters and dogs, the number of legs is 100 more than twice the number of heads. How many dogs are in the group?	
2. A father's will divides his estate of 'n' thousand dollars among his four children so that his oldest gets ½ of his estate; his second oldest gets ¼; his third oldest gets 1/5; and his fourth child gets $7000. What is the dollar value of the father's estate?	
3. Given a circle with two parallel tangents to the circle. Find the number of points that are equidistant from the circle and the two parallel tangents.	
4. The average of a set of 10 test scores is 80. If the highest score of 96 and the lowest score of 40 are discarded, find the average of the remaining test scores	

Fig. 1: *Practice Mathematics Contest*

2. **Reason abstractly and quantitatively.** *Mathematically proficient students make sense of quantities and their relationships in problem situations. Students bring two complementary abilities to bear on problems involving quantitative relationships: a. the ability to decontextualize, to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own without necessarily attending to their referents; b. the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.*

3. **Construct viable arguments and critique the reasoning of others.** *Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. They justify their conclusions, communicate them to others and respond to the arguments of others.*

4. **Model with mathematics.** *Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that they may need revision*

later. They are able to identify important quantities in practical situation and map the relationships using tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense.

5. **Use appropriate tools strategically.** *Mathematically proficient students consider the available tools when solving a mathematical problem. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations. Such students are able to use technological tools to explore and deepen their understanding of concepts.*

6. **Attend to precision.** *Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbol they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the problem context.*

7. **Look for and make use of structure.** *Mathematically proficient students look closely to discern a pattern or structure. These students step back for an overview and shift perspectives. They can see complicated things as single objects or as being composed of several objects.*

8. **Look for and express regularity in repeated reasoning.** *Mathematically proficient students notice if calculations are repeated, and look both for general methods and for shortcuts. As they work to solve a problem, mathematically proficient students maintain oversight of the process while attending to the details. They continually evaluate the reasonableness of the intermediate results.* (CCSSM, 2011, p.6).

According to Partnership for Assessment of Readiness for College and Careers (PARCC), "Mathematical practices should be evident throughout mathematics instruction and connected to all of the mathematical content areas, . . . as well as all other content areas addressed at each grade level" (PARCC, 2012, p. 16).

Let's review each of the four sample practice problems to determine which practice standards would be required for a student to use to determine the answer (See Figure 2).

Of course, some may argue that other Standards for Mathematical Practice may be present in these problems, and we do not deny this. However, the point of this analysis is to recognize the absence of problems that require a student to construct viable arguments or critique the reasoning of others.

Is there room for such standards to be included in the Statewide Mathematics Contest? Could students be asked to present findings to a panel of judges, allowing the presentation of findings to account for part of the individual and team scores? Will written test problems such as the sample practice problems above, include the requirement of justifying in words the solution to each problem? These and many such questions will need to be considered as the 2014 - 2015 school year approach, the year in which these standards will be fully assessed nationally for the first time. How will these changes affect the format of future competitions?

	Standard(s) for Mathematical Practice
1. In a group of hunters and dogs, the number of legs is 100 more than twice the number of heads. How many dogs are in the group?	1, 2, 7, 8
2. A father's will divides his estate of 'n' thousand dollars among his four children so that his oldest gets ½ of his estate; his second oldest gets ¼; his third oldest gets 1/5; and his fourth child gets $7000. What is the dollar value of the father's estate?	1, 2, 4, 7, 8
3. Given a circle with two parallel tangents to the circle. Find the number of points that are equidistant from the circle and the two parallel tangents.	1,4, 7
4. The average of a set of 10 test scores is 80. If the highest score of 96 and the lowest score of 40 are discarded, find the average of the remaining test scores	1, 2, 5, 6

Fig. 2: *Standards for Mathematical Practice*

References

Common Core State Standards Imitative (2011). *Common core state standards for mathematics*. Retrieved on January 3, 2012 from http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf.

Flick, M. & Kuchey, D. (Spring 2010). Finding the right mathematical task. *Ohio Journal of School Mathematics, 61*, 43-47.

Partnership for Assessment of Readiness for College and Careers (2012). *PARCC model content frameworks-mathematics*. Retrieved on January 3, 2013 from http://www.parcconline.org/sites/parcc/files/PARCCMCFMathematicsNovember2012V3_FINAL.pdf

Deborah Kuchey, Ed.D., kuchey@xavier.edu, is currently the College Representative for the Greater Cincinnati Council of Teachers of Mathematics. Dr. Kuchey is an Associate Professor and Director for the Elementary Math Specialist Program at Xavier University, where she works in the Department of Childhood Education and Literacy as the Early and Middle Childhood Math Educator.

Michael Flick, Ph.D., flick@xavier.edu, has served the Ohio Council of Teachers of Mathematics as State Contest Coordinator for over 25 years. He has received numerous teaching awards and honors. Dr. Flick is Professor, Director of the Center For Excellence In Education, and Chair of the Department of Secondary and Special Education at Xavier University.